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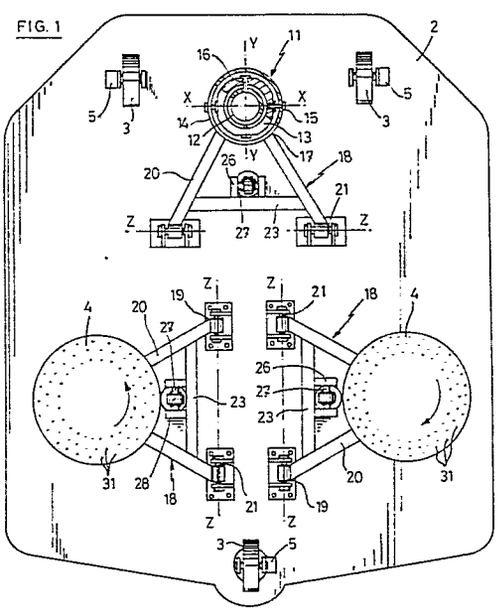
(54) Submarine vehicle.

(57) The vehicle which is movable on underwater surfaces, consists of a frame (1) provided with driving wheels (3), at least one suction element (4;33) which is intended to press the vehicle against an underwater surface (30) during the movement of the vehicle on this surface (30) and at least one arm (18) having one end (19) which is hingedly connected to the frame (1) and another end (17) which is connected to the suction element (4;33).

The vehicle is characterized in that a double-acting hydraulic cylinder (25) is hingedly connected to the frame (1) and to the arm (18), between the ends (17,19) of the latter, said cylinder (25) being intended to exert on the suction element (4;33) a force, so that a constant and adjustable pressure is maintained between the suction element and said surface (30), whatever be the form or the unevenesses of the surface (30) with which the vehicle is in contact.

FIG. 1



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Description

SUBMARINE VEHICLE

This invention relates to a vehicle which is movable on underwater surfaces, such as ship hulls, submarine parts of oil rigs and the like.

Said vehicle comprises a frame provided with driving wheels or caterpillars, at least one suction element which is intended to press the vehicle against an underwater surface during the movement of the vehicle on this surface and at least one arm having one end which is hingedly connected to the frame and an opposite end which is connected to the suction element.

The vehicle according to this invention can be used either for cleaning or inspecting underwater surfaces, particularly for removing marine growths from said surfaces, for polishing these surfaces or for discovering damages or defects of said surfaces.

For treating underwater flat or curved structures, it is known to use vehicles equipped with metal brushes or scrapers which rotate at a high speed in contact with an underwater surface to be treated.

Due to this high speed of said brushes or scrapers, an underpressure is created between the surface to be treated and said brushes or scrapers. This underpressure is due to the centrifugal effect of the immersed rotating treating elements.

This underpressure creates a suction force between the vehicle to which the treating elements are attached and the surface to be treated, so that the vehicle is firmly pressed against said surface.

The value of the suction force depends on various factors such as the rotation speed of the treating elements, the diameter of these elements which have a circular form, the distance between said elements and the surface to be treated, the structure and the roughness of the treating elements, such as the brush bristles, and the surface to be cleaned.

However, when said factors have been fixed, they can no more be changed during the operation of the vehicle. This means that the suction means of the vehicle cannot be adjusted as a function of the instant circumstances, such as the type of growth, the roughness of the surface to be treated, the type of the paint or protecting layer applied on the surface and the like.

In the known systems, said suction force can in fact only be influenced by changing the diameter of the treating elements, the rotation speed of the latter, the roughness of the brushes or scrapers, or the distance between the treating elements (brushes or scrapers) and the surface to be treated.

When each of these factors is modified, the efficiency of the apparatus is detrimentally affected. This means that the area which can be treated per hour and the quality of the treatment are affected in various ways.

When the diameter of the treating elements is decreased, the treated surface becomes smaller and, if the vehicle is provided with several treating elements, a part of the surface remains untreated, since there is no overlap between the treating elements due to the decrease of said diameter.

When the rotation speed of the treating elements is decreased, the cleaning speed is strongly reduced.

When the distance between the support of the bristle brushes and the surface to be treated must be increased, the length of the bristles of said brushes must be increased, so that said bristles become easily flattened against said surface.

The suction force can also be decreased by diminishing the number of bristles of the brushes, but this affects also detrimentally the efficiency and the life time of the brushes.

GB-A-2 155 771 describes an apparatus for treating an underwater surface, which comprises a first treating brush or pad connected to one end of a first bell-crank lever, the other end of which is connected through a rod carrying a piston of a hydraulic cylinder to one end of a second bell-crank lever, the other end of which is connected to a second treating brush.

The use of a single hydraulic cylinder in this known apparatus does not allow to adjust individually the suction force of each brush against the surface to be treated. Therefore, if the suction force exerted by one brush is too high, this brush may damage the treated surface.

An object of this invention is a vehicle which can be used for treating or inspecting underwater surfaces which may have a high or small radius of curvature.

Another object of this invention is a vehicle which allows a stepless adjustment of the suction force of the suction elements without using any tool, such an adjustment being also possible during the operation of the vehicle, said suction force being independent from a variation of the dimensions of the treating elements, such as brushes or scrapers.

Still another object of the invention is a vehicle which is arranged so that the suction force remains constant, whatever be the position of the suction elements and whatever be the form and the unevenesses of the surface to be treated or inspected.

This invention relates to a vehicle which is movable on underwater surfaces and comprises a frame provided with driving wheels or caterpillars, at least one suction element which is intended to press the vehicle against an underwater surface during the movement of the vehicle on this surface and at least one arm having one end which is hingedly connected to the frame and an opposite end which is connected to the suction element, said vehicle being essentially characterized by the fact that a double-acting hydraulic cylinder is hingedly connected to the frame and to the arm, between the ends of the latter, said cylinder being intended to exert on the suction element a force, so that a constant and adjustable pressure is maintained between the suction element and said surface, whatever be the form or the unevenesses of the surface with which the vehicle is in contact.

According to a feature of the invention, each suction element is suspended in a cardan system at one end of said arm.

In a particular embodiment of the invention, the arm comprises two parts which are laterally spaced from each other, which are each hingedly connected at one of their ends to the frame and which are attached, at their other end, to a common ring to which the cardan system is suspended. The two parts of the arm are preferably connected to each other by a transverse beam on which the hydraulic cylinder acts.

The suction elements provided in the vehicle according to this invention may be brushes or scrapers, when the vehicle is used for cleaning underwater surfaces. Said suction elements may consist of rotating elements, such as bladed wheels, turbines, propellers or discs, provided with rollers which are intended to roll onto the underwater surfaces, so as to avoid any contact between said rotating elements and said surfaces. Such rotating elements are used when the vehicle, which may carry a camera, is used for inspecting said surfaces.

The vehicle according to this invention may be operated and guided by a diver or by remote control means.

Other features of the submarine vehicle according to this invention will appear in the following detailed description in which reference is made to the attached drawings, in which :

- Fig.1 is a front view of the bottom of an embodiment of a vehicle according to the invention ;
- Figs.2 and 3 are side views of the vehicle shown in fig.1, in which an arm to which a brush is connected through a cardan or gimbal system is applied against a surface to be cleaned ;
- Fig.4 is a front view of a suction element consisting essentially of a propeller used in another embodiment of the vehicle according to the invention ;
- Fig.5 is a cross-section of the suction element along the line V-V of fig.4, and
- Fig.6 is a front view of a suction element consisting essentially of a bladed wheel or turbine which may be used instead of the propeller shown in figs.4 and 5.

In these figures, the same references designate identical parts of the vehicle.

The vehicle shown in figs.1 to 3 comprises a frame or housing 1, a bottom plate 2, three wheels 3 and three cylindrical rotating brushes 4. Instead of brushes, scrapers or abrasive discs may be used.

Each wheel is operated by a hydraulic motor 5. The output of this motor 5 can be adjusted by a regulator 6, such as a valve which is operated by a control device 7.

By adjusting the output of the hydraulic motor 5, the speed of the movement of the vehicle onto a surface to be cleaned or inspected may be adapted to the requirements.

In fig.1, the vehicle comprises one forewheel and two backwheels. The forewheel can be randomly oriented according to the direction of movement of the vehicle onto the surface to be treated or inspected.

The number of wheels 3 may of course vary in accordance with the dimensions of the vehicle. These wheels may be replaced by caterpillars.

Each disc-like brush 4 is fixed on the shaft or rod 8 of a hydraulic motor 9, the speed of each motor being possibly adjustable by means of an output regulator operated by a control device 10 provided on the housing 1; said control device 10 may be operated by the diver which drives the vehicle. Said control device 10 may of course also be a remote control device mounted on a ship, a platform or a wharf.

Each brush 4 and the hydraulic motor 5 thereof are suspended to a cardan system or gimbal 11. This system consists of three coaxial rings 12, 13, 14 which are arranged so that two inner rings 12, 13 can pivot with respect to the outer ring 14 about two axes X-X and Y-Y which are perpendicular to each other.

The ring 13 is hingedly connected to the outer ring 14 by means of two opposite pivots 15 (axis X-X), whereas the ring 12 is connected to the ring 13 by means of two opposite pivots 16 (axis Y-Y).

Each hydraulic motor 9 which actuates a brush 4 is fixed to the ring 12 of the cardan or gimbal system 11.

To the outer ring 14 is fixed one end 17 of an arm 18, the other end 19 of which is hingedly connected (axis Z-Z) to the bottom plate 2. The arm comprises two parts 20 which are laterally spaced from each other. At one of their corresponding ends 17, these parts 20 of the arm 18 are fixed to the outer ring 14. At their other end, the parts 20 of the arm can pivot about pins 21, with respect to the bottom plate 2 in the direction of the arrows 22.

Between their two ends 17, 19, the parts 20 of the arm 18 are connected by a crosspiece 23 to which the rod 24 of a piston (not shown) of a double-acting hydraulic cylinder or jack 25 is hingedly connected, said cylinder 25 being able to pivot about a pivot 32.

Two parallel ears 26 fixed to the crosspieces 23 carry a pin 27 about which the free end 28 of the piston rod 24 may rotate.

The pressure of each cylinder 25 can be adjusted by means of a regulator provided with a control device 29.

In accordance with the force exerted by the rod 24 of the piston of the cylinder 25 on the arm 18, this arm 18 take a more or less inclined position (see on the right of fig.3).

Due to the fact that the cylinders 25 can cause the corresponding arms 18 to pivot more or less in the direction of the arrows 22, underwater surfaces, such as surfaces 30 having different radii of curvature, may be cleaned by the brush bristles 31 which always remain in contact with said surfaces.

By actuating the pressure regulators 47 between the hydraulic supply and the cylinders 25, it is possible to adjust the pressure of the brushes 4 against the surface 30 to be treated. Said pressure can be adjusted in accordance with the thickness and type of the growth to be removed and of the paint layer on the surface to be treated.

The variation of pressure in the hydraulic cylinders 25 will modify the pressure of the treating elements, such as the brushes 4, against the surface to be treated 30. The suction force of the treating elements 4 is not modified by variations of the pressure in the hydraulic cylinders 25. These variations will only modify the pressure of the treating elements 4 against the surface 30. The suction force of the treating elements 4 lings the vehicle against this surface 30. A reaction force is transmitted by the surface to the vehicle through the wheels 3 and the treating elements 4. The variations of the oil pressure in the hydraulic cylinders 25 will change the distribution of this reaction force between the wheels 3 and the treating elements with, as a consequence, the possibility to modify the pressure between the surface 30 and the treating elements 4.

Of course, the brushes 4 may be replaced by other treating elements, such as scrapers or abrasive circular discs.

As shown in fig.1, the vehicle according to the invention may comprise three brush-carrying mechanisms, whereby the pivoting axis Z-Z of one arm 18 forms an angle of 90° with the pivoting axis of the two other arms 18.

Figs. 5 and 6 show a suction element 33 which replaces the brushes 4 or scrapers, when the vehicle has to be used for inspecting an underwater surface, in order to detect damages or defects on this surface. The suction element shown in figs. 5 and 6 comprises a propeller 34 fixed on the shaft 8 of the motor 9. The propeller 34 is surrounded by a rotating housing 35 which is also fixed by radial arms 36 to said shaft 8. The housing 35 carries fixed pins 37 on which rollers 38 can freely rotate. These rollers 38 may roll on the surface 30 and avoid any contact between the propeller and its housing 35 and said surface 30.

Openings 39 are provided in the housing 35, for example in the cylindrical sidewall 40 of the latter, for expelling the water sucked in the housing 35 by the propeller 34.

A camera 45 carried, for example, by a bracket 41 fixed to the frame 1 of the vehicle may be used for inspecting the surface 30. This camera may of course be rotatable and may also be mounted within the frame 1. In any case, the lens 44 of the camera must be directed toward the surface to be inspected. The camera 45 is of course connected to a video-screen.

Fig. 6 is a view similar to that of fig. 5, wherein the propeller 34 is replaced by a bladed-wheel or turbine 42. The blades 43 of this wheel or turbine 42 are shaped so as to create a suction or aspiration of water. In this embodiment, the central part 46 on which the blades 43 of the wheel are fixed carries rollers 38 having the same function as the rollers shown in figs. 4 and 5.

Claims

1. A vehicle which is movable on underwater surfaces, consisting of a frame (1) provided with driving wheels (3) or caterpillars, at least one suction element (4;33) which is intended to press the vehicle against an underwater surface (30) during the movement of the vehicle on this surface (30) and at least one arm (18) having one end (19) which is hingedly connected to the frame (1) and another end (17) which is connected to the suction element (4;33), characterized in that a double-acting hydraulic cylinder (25) is hingedly connected to the frame (1) and to the arm (18), between the ends (17,19) of the latter, said cylinder (25) being intended to exert on the suction element (4;33) a force, so that a constant and adjustable pressure is maintained between the suction element and said surface (30), whatever be the form or the unevenesses of the surface (30) with which the vehicle is in contact.

2. A vehicle according to claim 1, characterized in that each suction element (4;33) is suspended to a cardan or gimbal system (11) at one end (17) of the arm (18).

3. A vehicle according to claim 1, characterized in that the arm (18) consists of two parts (20) which are spaced laterally from each other and which are each hingedly connected, at one of their corresponding ends (19), to the frame (1), said arm parts (20) being attached, at their other end (17), to a common ring (14) to which a cardan or gimbal system (11) is suspended.

4. A vehicle according to claim 3, characterized in that the two parts (20) of each arm (18) are connected by a crosspiece (23) on which the cylinder (25) acts.

5. A vehicle according to anyone of the preceding claims, characterized in that it is provided with three arms (18), the pivoting axes (Z-Z) of two of these arms being parallel to each other, whereas the pivoting axis (Z-Z) of the third arm forms an angle with the pivoting axes (Z-Z) of the two first arms.

6. A vehicle according to claim 5, characterized in that said angle has a value of about 90°.

7. A vehicle according to anyone of the preceding claims, characterized in that each suction element (4) consists of a circular rotating brush (4) or scraper for the treatment of said underwater surfaces (30).

8. A vehicle according to anyone of claims 1 to 6, characterized in that the suction element consists of a rotating element (33) provided with rollers (38) which are able to rotate in contact with said underwater surface (30) and avoid a contact between said rotating element (33) and said surface (30).

9. A vehicle according to claim 8, characterized in that the suction element consists of a bladed wheel or turbine (42).

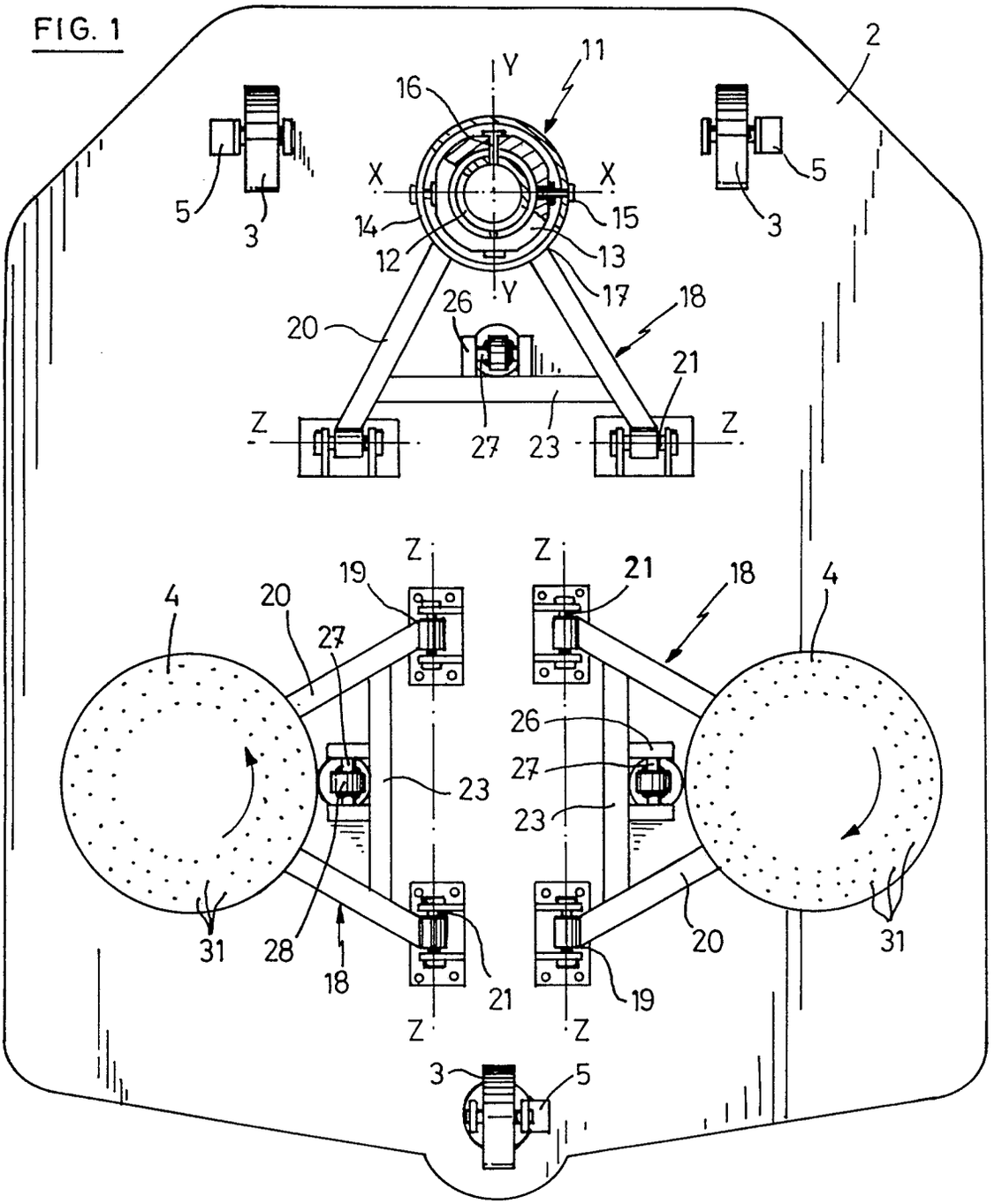
10. A vehicle according to claim 8, charac-

terized in that the suction element consists of a propeller (34).

11. A vehicle according to claim 8, characterized in that the suction element consists of a disc.

12. A vehicle according to anyone of the preceding claims, carrying a camera (45) for inspecting the surface on which the vehicle is moved.

FIG. 1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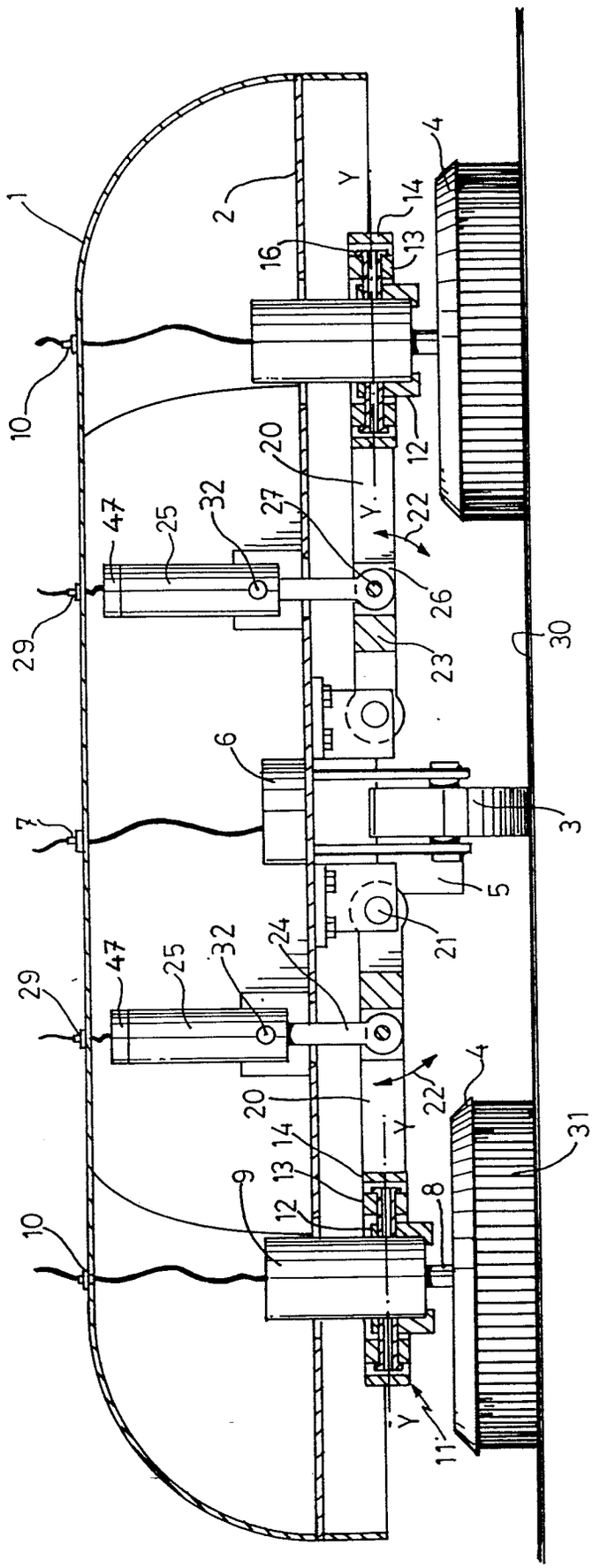

FIG. 2

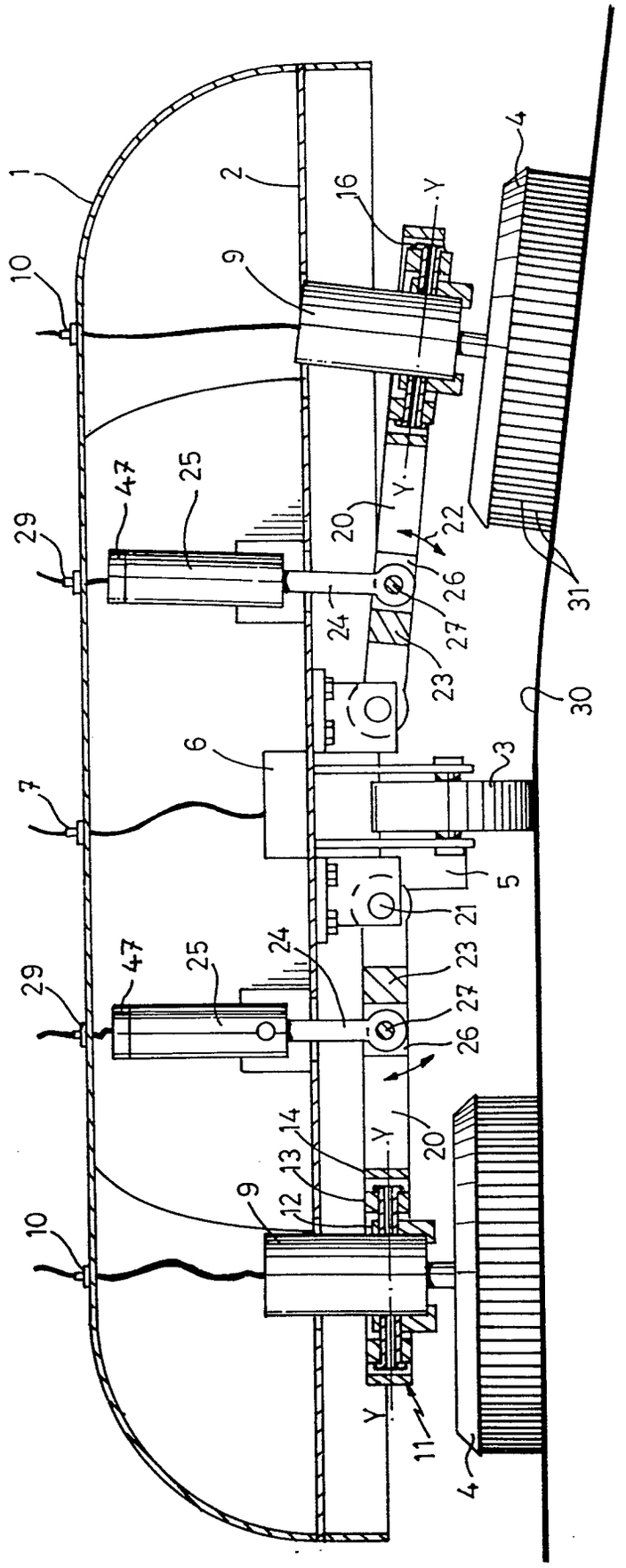
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FIG. 3

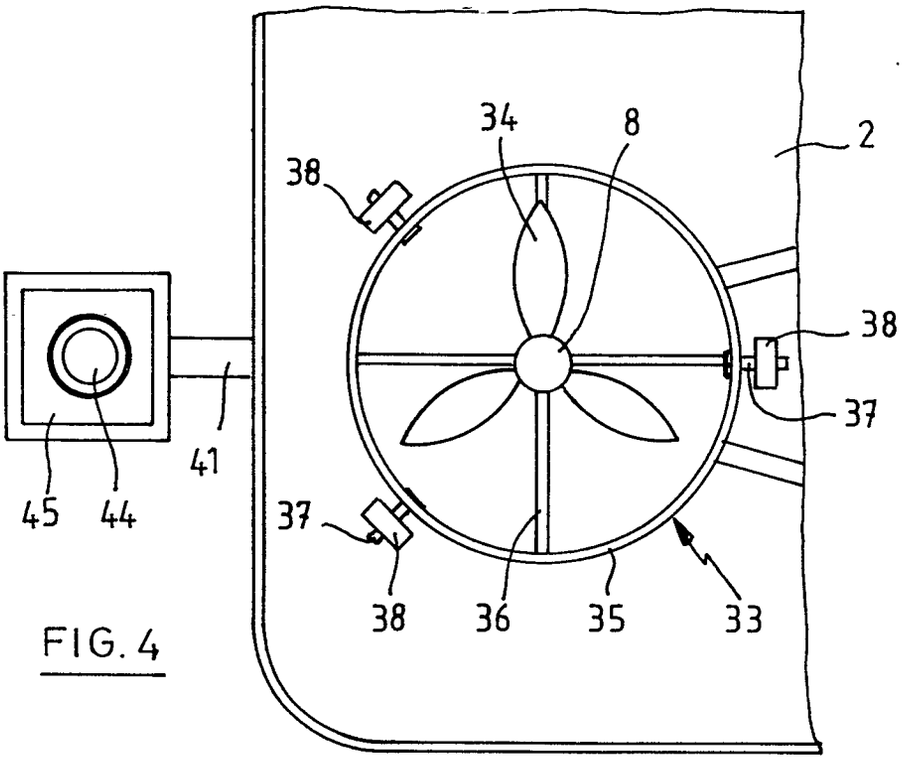
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FIG. 4

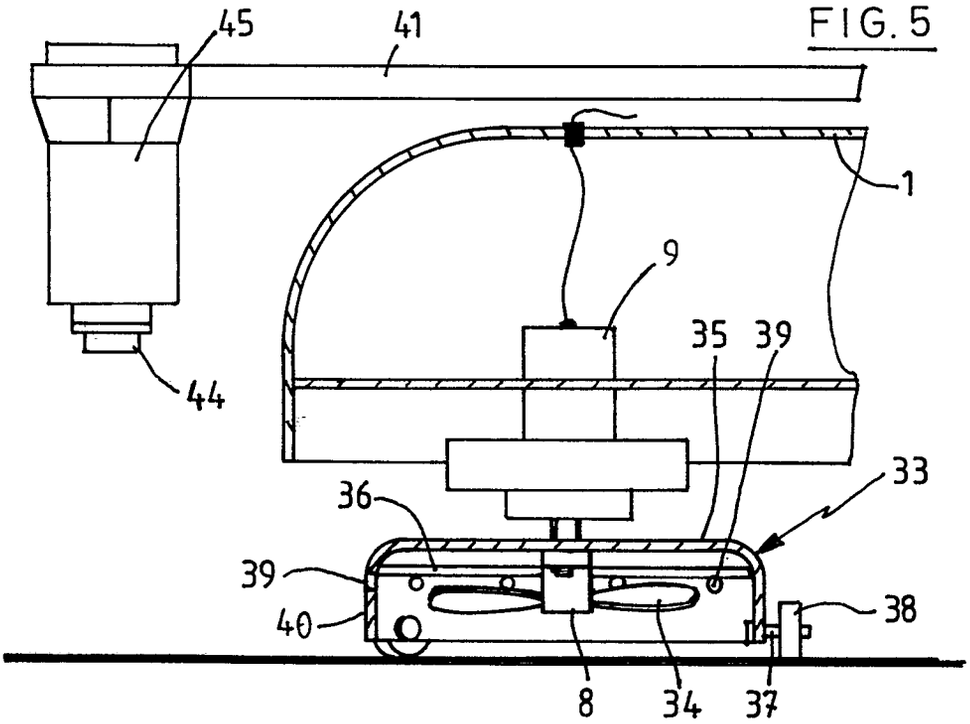
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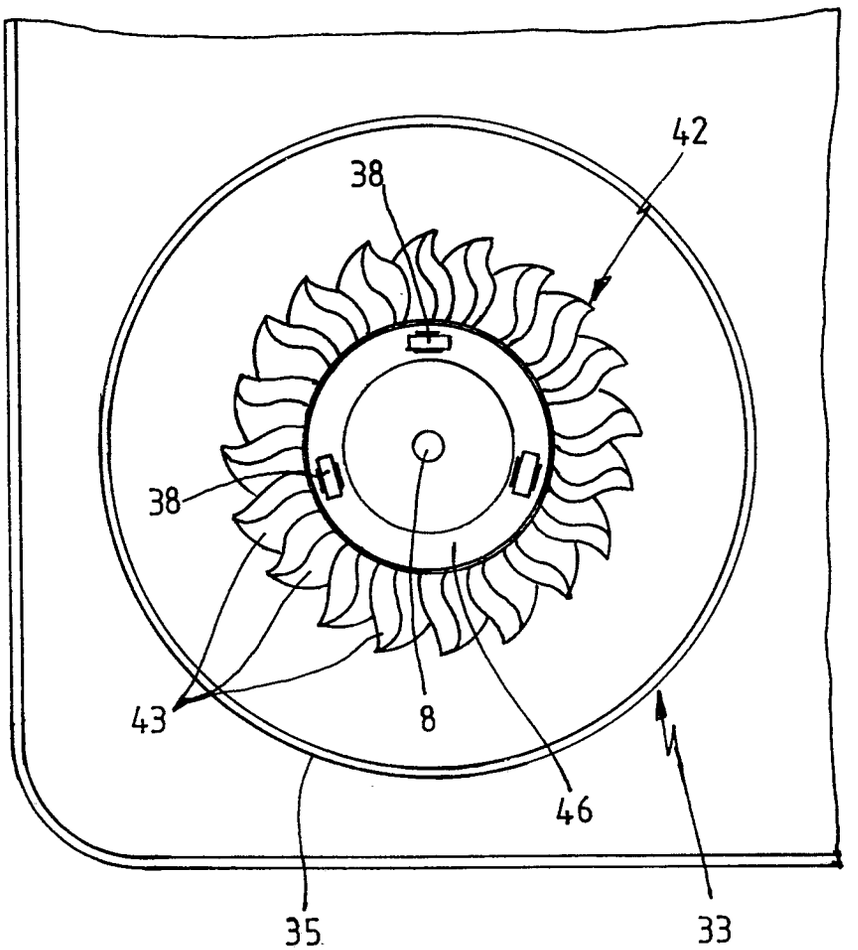
FIG. 5

FIG. 6



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EUROPEAN SEARCH REPORT

Application Number

EP 88 87 0062

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A,D	GB-A-2 155 771 (JONES) * Whole document *	1-3,7	B 63 B 59/10
A	NAVY TECHNICAL DISCLOSURE BULLETIN, vol. 5, no. 7, July 1980, pages 49-54; D.J. HACKMAN et al.: "Underwater ship and submarine hull cleaning unit" * Figure 1 *	2,7	
A	BE-A- 843 312 (JOTUNGRUPPEN) * Page 7, line 29 - page 8, line 9; figures 3,4 *	1,8,9	
A	FR-A-2 369 964 (LUNDBERG) * Page 5, lines 7-16 *	8,11,12	
A	FR-A-2 569 140 (INTERNATIONAL ROBOTIC ENGINEERING INC.)		
A	EP-A-0 131 987 (VAN ROMBAY)		
A	FR-A-1 580 337 (OUTIPERRET)		TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 63 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-06-1988	DE SCHEPPER H.P.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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